

# RETRACTABLE CABLE WINDER

## FIELD OF THE INVENTION

5           This invention relates to a cable winder which allows only the retractable end of a cable to be released and winded up while the other end of the cable remains stored inside the cable winder without being damaged by the winding action of the cable which commonly occurs due to axial twisting on the cable. The invention can be also used for optical fiber cables, as well as non-optical fiber cables, such as cooper or steel or other wires and cables.

## BACKGROUND OF THE INVENTION

10           Cable winders are quite common amongst cable users for storing telephone or other utility cords. By using a cable winder, the user avoids the messy twisting, kinking, crinkling and coiling up of extended cables. However, a major problem with the conventional cable winders is the axial twist created by the winding action of the stored cable along the rotational axis of the winder case.

15           This axial twist often results in cable damage since for every turn of winding the cable, it twists the centre core 360°. The more turns the cable winds, the greater the damage is resulted from the axial twist. While ordinary electrical cables may be able to sustain some extents of twisting, it will create unmanageable damages to optical fibre cables due to the inherent physical properties of  
20           these cables which limit the bending radius of the optical fibre within the cable.

          One solution to solve this problem was to extend the stored cable from both ends of a cable winder such that the axial twisting action created by extending one end of the cable is compensated by the axial twisting action created by extending the other end of the cable in an opposite direction.

An example is shown in US Patent Application No. 09/963,264 (published on April 11, 2002). Such traditional double extension method is evidently unsatisfactory for the simple reason that it is undesirable to extend both ends of the cable.

Attempts have been made to address this double extension shortcoming in the prior art. For example, US Pat. No. 5,094,396 (issued March 10, 1992 to Burke) teaches a telephone cord retractable reel assembly which allows one end of the phone cord to extend while the other end remains stationary. Similarly, US Pat. No. 5,718,310 (issued February 17, 1998 to Gallo) discloses a telephone cord winder which does not require both ends to be extended at the same time. These winders are designed for telephone cords and are not suitable for optical fibre cables since electrical circuitry connectors are required in telephone cord reels to ensure conductivity of electric signals. In US Pat. No. 5,655,726 (issued August 12, 1997 to Peterson et al.), an uni-directional cord take-up reel which devoid the need for electrical connectors is disclosed. Another example for such cord reel is shown in US Pat. No. 6,405,961 (issued June 18, 2002 to Mastrangelo) directed to optical fiber cable storage. These types of reels, however, are still subject to axial twisting as the reel turns and causes the cable to be twisted in the middle region of the reel.

Endeavours have also been made to minimize attenuation of the minimum-bending radius of optical fiber cable with a view to preserving the physical property of the cable. For instance, US Pat. No. 6,349,893 (issued February 26, 2002 to Daoud) teaches a retractable storage reel specifically designed for optical fiber cables by ensuring the minimum radius of curvature of the reel barrels is equal to or greater than the minimum bend radius of the optical fiber cable. However, this design requires the cable to be extended from both ends simultaneously. In US Pat. No. 6,220,413 (issued April 24, 2001 to Walters et al.), it provides for an optical fiber cable reel

which avoids the axial twist problem. However, a user must return the connector panel to the centre of the reel before extending or retracting the cable, thus requiring the user to remove all connection every time when the reel is used.

It is therefore highly desirable to design a cable winder which only extends and retracts one end of the cable and, at the same time, avoids the damaging effects created by axial twisting and yet able to minimize the attenuation of the cable due to bending.

It is also advantageous to be able to lock a portion of a paid-out length of the extended cable by ratchet-pawl action, and to automatically rewind the extended cable by simply releasing the ratchet-pawl lock without having the need to resort to special tools.

## SUMMARY OF THE INVENTION

The present invention provides a retractable cable winder which enables a paid-out length of a retractable cable to be extended from the winder without the need to also extend the other stationary end of the cable. The design of the winder according to the present invention enables the stationary end of the cable to curl up inside the buffer compartment of the winder. As the retractable end extends, the upper and lower track reels, which store the retractable cable, also turns. Since the stationary cable is a continuation of the retractable cable, the turning force of the track reel compels the stationary cable to turn in an opposite direction within the circular buffer compartment. Since the buffer compartment is relatively large, the stationary cable simply starts to curl up and slowly tightens around the buffer reel seat located at the center of the buffer reel. After use, as the retractable cable is being retracted and winded up inside the winder, the stationary cable within the buffer compartment will turn in the opposite direction and becomes loosely curling

around the reel seat. Thus, the winder of the present invention enables the user to extend and to retract a predetermined length of a cable by simple actions, with relative ease and without the need to use any tool.

It is a principal object of the invention to provide an improved cable winder which only  
5 extends one end of the cable and still preserves the physical properties of the cable. In the case of optical fiber cables, the construction and operation of the improved cable winder eliminates any damages to the optical fiber created by axial twisting on the cable. Accordingly, the present invention provides for a cable winder for retractably extending a cable from a retractable end of the cable, while the other end of the cable remains stationary and curling up inside the cable winder,  
10 the winder comprising a front and a back housing, whereby the housing defines a stationary cable buffer compartment, a retractable cable compartment, a lock compartment and a coil-spring compartment, wherein (i) the stationary cable buffer compartment comprises a stationary cable buffer reel with a reel seat substantially smaller in diameter than the buffer reel and located in the center of the reel for windingly loosening and tightening the stationary end of the cable within the  
15 buffer compartment; (ii) the retractable cable compartment comprises an upper and a lower spiral track reels with spiral tracks provided thereon, wherein the center of the reels is in rotatable communication with a retractable coil-spring shaft and a predetermined length of the retractable end of the cable being stored in the upper and lower spiral tracks; the cable operatively continues to become the stationary end after passing through a through hole provided on the spiral track reels  
20 therein; (iii) the lock compartment comprises a ratchet reel lockable by a pawl lock arm and operatively engaged to the retractable coil-spring shaft; and (iv) the coil-spring compartment comprises a coil-spring demountably engaged to the retractable shaft attached to the inside of the

back housing, whereby a receiving slot is provided on the shaft for torsionally coupled to the spiral track reels and the ratchet reel.

## BRIEF DESCRIPTION OF THE DRAWINGS

5 Advantages and features of the invention will become more apparent with reference to the following description of the presently preferred embodiment thereof in connection with the accompanying drawings, wherein like references have been applied to like components, in which: **Figure 1** is a front perspective view of the retractable optical fiber cable winder of the present invention;

10 **Figure 2** shows an exploded view of the various components of the cable winder of the present invention;

**Figure 3a** and **Figure 3b** are two slightly different perspective views showing the upper spiral track reel with the retractable cable wound within the spiral groove;

15 **Figure 4a** and **Figure 4b** are two slightly different perspective views showing the underside of the lower spiral track reel with the stationary cable extending from the cable transition through hole;

**Figure 5** is a schematic drawing showing the orientation of the retractable cable resting in the spiral reel, and the stationary cable loosely curled around the buffer reel;

**Figure 5a** and **Figure 5b** are schematic drawings showing, separately and respectively, the orientation of the retractable cable resting in the spiral reel, and the stationary cable loosely curled  
20 around the buffer reel;

**Figure 6** is a schematic drawing showing the orientation of the retractable cable extending from the spiral reel, and the stationary cable just begins to curl around the buffer reel;

Figure 6a and Figure 6b are schematic drawings showing, separately and respectively, the orientation of the retractable cable extending from the spiral reel, and the stationary cable curling around the buffer reel;

Figure 7 is a schematic drawing showing the orientation of the retractable cable being extended nearly completely from the spiral reel, and the stationary cable curled tightly around the buffer reel;

Figure 7a and Figure 7b are schematic drawings showing, separately and respectively, the orientation of the retractable cable being extended nearly completely from the spiral reel, and the stationary cable curled tightly around the buffer reel;

Figure 8 is another front perspective view of the retractable optical fiber cable winder of the present invention showing the spring-urged pawl lock slightly off-centred on the front cover housing.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The retractable cable winder of the present invention is comprised of the front and back housings. Inside the winder, there are four compartments, namely a stationary cable buffer compartment, a retractable cable compartment, a coil-spring compartment and a lock compartment.

Referring to Figures 1 and 2, Figure 1 shows a perspective view of the cable winder 100 of the present invention. The end portion of stationary cable 102 projects out from the housing through aperture 106, while the end portion of retractable cable 104 projects out from the housing through aperture 108 (see Figure 2).

Figure 2 shows an exploded view of the cable winder of the present invention. The inside

of the back cover housing **110** has a circular periphery sufficiently large enough to define the space required for the cable buffer compartment and the coil-spring compartment. The bottom side of the back cover housing **110** is substantially flat to enable the winder to rest on a flat surface. Housing fastening boss **114** and corresponding fastening bore **116** are provided for joining the front and back cover housings together.

A retraction shaft **302** is provided at the center of back cover housing **110**. Along the longitudinal center of shaft **302** is a retraction shaft-receiving slot **304**. A conventional coil-spring **306** is biasedly mounted to the retraction shaft-receiving slot **304** within the coil-spring compartment **504**. Coil-spring **306** operatively engages to the other rotational reels and is discussed further below. Coil-spring **306** compresses in a helical fashion as the retractable cable extends, thereby generating a torsional force which allows the ratchet reel **412** step-lock and control the paid-out length of the retractable cable. The user can therefore stop the cable extension at any desirable position.

Above the coil-spring sits the buffer reel **402** which houses the stationary cable **102**. Buffer reel **402** is not operatively engaged to the retraction shaft **302** though when it rotates, it revolves along shaft **302**. Buffer reel **402** defines a relatively large circular space that forms the stationary cable buffer compartment **502**. A buffer reel seat **404** is located at the center of buffer reel **402**. Buffer reel seat **404** is substantially smaller in diameter than buffer reel **402** and is used for windingly loosening and tightening the stationary cable within the buffer compartment **502**.

For optical fibre cables, care must be taken to preserve the minimum-bending radius of the cable. It is recommended that the diameter of reel seat **404** be at least the same or slightly larger than the bending radius of the optical fiber cables. For example, if the bending radius of the cable

is 10 mm, then the diameter of the reel seat **404** should be at least 10 mm. For cables other than optical fibre cables, the diameter of the reel seat can be of any size suitable to accommodate the total paid-out length and thickness of the cable.

The circular space in the buffer compartment **502** allows stationary cable **102** to be stored (see Figures 5, 6 and 7). Stationary cable **102** curls around the reel seat **404**. Due to the inherent biasing force exerted by the cable, stationary cable **102** naturally expands against the periphery wall along the back cover housing **110** when in stored position (see Figure 5b).

Abutting and located above the buffer reel **402** is the retractable cable compartment **506**. Within retractable cable compartment **506** are two spiral track reels, namely upper spiral track reel **406** and lower spiral track reel **406'**, for housing the retractable cable **104**. The upper and lower spiral track reels are contiguously attached to each other. The upper and lower spiral track reels are essential to the functioning of the present invention. Together, they enable the cable to be winded continuously without being bended or twisted. Optionally, a cable slit **410** (see Figure 2) is provided to facilitate easy insertion of the cable when the cable is placed inside the winder for the first time. Cable slit...(continues with the sentence below – will be fixed for submission) Cable slit **410** extends radially from the outboard edge of the upper and lower spiral track reels to spiral track **408** (see below). The upper and lower spiral track reels rotationally engage to coil-spring **306**.

As shown in Figures 3a and 3b, a spiral track **408** is provided on the upper spiral track reel **406**. The spiral track takes the name from its configuration since it spirals on upper track reel **406** with track **408** to define the storage groove for the retractable cable **104**. As with the dimension of buffer reel seat **404**, the angle of turning on track **408** is designed to preserve the minimum-bending radius of commonly used optical fiber cables. Accordingly, the diameter of the



spiral track reels **406** and **406'** is at least the same or slightly larger than the bending radius of the optical fiber cables. For instance, if the bending radius of the cable is 10 mm, then the diameter of the track reels should be at least 10 mm. It is desirable that the length of track **408** is predetermined and corresponds to the length of the paid-out cable. If the winder is used for non-optical fiber  
5 cables, such as copper or steel or other metallic wires and cables, then the turning angle is of less relevance.

As can be seen from Figures 3a, 3b, 4a and 4b, while retractable cable **104** is stored in the groove of track **408**, it continues on and passes through the cable transition through hole **414** and emerges from the other side of cable transition through hole **414** located on the underside of the  
10 lower spiral track reel **406'**. After emerging from the through hole **414**, the emerged portion of the cable is referred to as the stationary cable which rests in the stationary cable buffer compartment **502**.

Figures 5, 5a, 5b, 6, 6a, 6b, 7, 7a and 7b show the configuration of the retractable and stationary cables and the orientation of the upper and lower track reels at different stages of the  
15 retractable cable unwinding operation.

Figures 5, 5a and 5b illustrate the cable in full storage position, i.e., completely retracted position. In this position, the full length of the retractable cable **104** rests wholly within track **408**, while the corresponding length of the stationary cable **102** curls up loosely against the periphery of the back cover housing **110** inside the stationary cable buffer compartment **502**.

Figures 6, 6a and 6b show position of the cable in the intermediate stage of extension. As  
20 the retractable cable **104** is being extended, the upper and lower spiral track reels **406** and **406'** rotate in the same direction as the retractable cable **104**. Since retractable cable **104** connects to the

stationary cable 102 through the through hole 414, the cable will not be subject to axial twist because it simply continues on as one cable. Even though buffer reel seat 404 is engaged to coil-spring 306 and turns as the retractable cable 104 extends, it does not prevent the stationary cable 102 from curling slightly tighter around the buffer reel seat 404. Thus, the circular space surrounding this area is designated “stationary” cable buffer compartment 502. This “anti-motion” phenomenon is a unique feature of the present invention because it eliminates the damaging attenuation effect caused by the torque created by axial twist of the retractable cable 104.

As retractable cable 104 continues to extend, the stationary cable 102 keeps on curling around the buffer reel seat 404 with increasing compactness, i.e., becoming tighter and tighter. However, in the case of optical fiber cables, since the diameter of the reel seat 404 is designed to preserve the minimum-bending radius of common optical fiber cable, even if stationary cable 102 is tightly curled up against reel seat 404, it will not cause any damage to the physical properties of the optical fiber cable. Figures 7, 7a and 7b show the fully extended retractable cable 104, with the stationary cable 102 tightly curled up inside the buffer compartment 502.

In order to achieve the best results, the length and the efficiency of the cable can be pre-determined in accordance with the following calculations and example.

Efficiency of cable is the length of the retractable portion of the cable  $L_1$  to the total cable length, which is the sum of  $L_1$ , the length of buffer compartment  $L_2$  and the stationary portion of the cable  $L_3$  in the retractable cable winder.

When the retractable portion of the cable warps around spiral track reel completely once with mean diameter  $E$ , the number of loop  $N$  in the spiral track reel is given by,

$$N = L_1 / \pi E. \quad (1)$$

Under this situation, the length of buffer compartment warps around buffer reel with number of loop M. When the retractable portion of the cable is pulled out completely, both spiral track reel and buffer reel rotate N turns and so the total number of loop in spiral reel is 0 while in buffer reel is M + N. Using this condition, the following equation is devised,

$$M \pi F = (M + N) \pi G$$

$$M = N G / (F - G) \quad (2)$$

5 where F is the mean diameter of loops in buffer reel when the retractable portion of the cable warps around spiral reel completely and G is the mean diameter of loops in buffer reel when the retractable portion of the cable is pulled out completely. As M is given by,

$$M = L_2 / \pi F, \quad (3)$$

where  $L_2$  is the length of buffer compartment. Thus, by substituting (1) and (3) into (2), the following relationship is obtained:

$$L_2 = L_1 F G / E (F - G) \quad (4)$$

10 and so the Efficiency of Cable is ascertained by,

$$\text{Efficiency} = L_1 / (L_1 + L_2 + L_3) \quad (5)$$

The parameters E, F, G and  $L_3$  are per-determined. If a target retractable cable length is known, the total cable required for the retractable cable winder can be readily established.

### Example

Assume the value of E, F, G, and  $L_3$  is 0.09, 0.08, 0.06 and 0.11 respectively, if the user  
 15 wants to know the Efficiency of Cable for 1m retractable cable, by equation (4) the user gets 2.67. The total cable length is  $1+2.67+0.11=3.78\text{m}$ . i.e. The Efficiency of Cable for the winder is

0.26. The cable winder of the present invention further comprises a ratchet reel **412** for locking and communicating with the spring-urged pawl lock button **202**. Ratchet reel **412** is located immediately above the upper spiral track reel **406** and is operatively engaged to the coil-spring **306**.

The locking and releasing mechanisms of the present invention consist of a pawl spring **212** urging against the pawl lock button **202**, which has a pawl spring lock arm **208** attached thereunder (see Figure 2). As the retractable cable **104** extends and the ratchet reel **412** rotates, the urging force exerted by the pawl spring **212** pushes the pawl spring lock arm **208** forward and engages one of the many ratchet reel teeth **210**, thereby step-locking the paid-out length of the retractable cable **104**, until the user stops pulling the retractable cable **104**. When the user wishes to retract the extended retractable cable **104**, the user simply pushes the spring-urged pawl lock button **202** away to disengage the pawl lock arm **208** from the ratchet reel teeth **210**. The torque force of the retractable coil-spring **306** returns the spiral track reels **406** and **406'**, together with the retractable cable **104**, back to the storage position.

Referring now to Figures 2 and 8, the present invention provides a front cover housing **112** in order to properly encase the cable winder. Front cover housing **112** mirrors the shape of back cover housing **110** so that the two covers snip fit onto one another at the closed position. Suitable pin-and-bore arrangement, such as bore **116** located at boss **114**, or other fastening means can be used to join the two housings. The spring-urged pawl lock button **202** is provided on the outside and located near but off the center of the front cover housing **112**. Lock button **202** passes through opening **214** on front cover housing **112** and protrudes through lock cover **204**. A slit **206** on lock cover **204** allows button **202** to be pushed away by a user and urgedly releasing the pawl lock arm **208** from the ratchet reel teeth **210** (see Figure 2), thereby enabling the retractable cable **104** to be

rewind into the winder.

As the retractable cable **104** is being rewind, the stationary cable **102** starts to uncurl around the buffer reel seat **404** in the stationary cable buffer compartment **502**. When retractable cable **104** is completely rewind, then the stationary cable **102** will return to its original configuration, i.e., loosely curled against the periphery wall along back cover housing **110** (see Figures 5, 5a and 5b).

It is readily understood that the shape of the front and back cover housings **112** and **110** is not limited to those disclosed herein. Likewise, any suitable biasing means able to urge the retraction mechanism and the spring-urged pawl lock mechanism with functional equivalence is within contemplation of the present invention. The coil-spring **306** and pawl spring **212** are merely examples of preferred embodiments disclosed in this invention herein.

Hence, although the present invention has been described with referenced to the preferred embodiment, it will be appreciated by those skilled in the art that various modifications, alternations, variations, and substitutions of parts and components may be made without departing from the spirit and scope of the invention. Therefore, the present application is intended to cover such modifications, alternations, variations, and substitutions of parts and components.